THE JUNIOR LIBRARY OF ECOLOGY

Protecting our FORESTS

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PROTECTING OUR FORESTS

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The Junior Library of Ecology

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The Forest as an Ecosystem

The forest's structure is created by living trees. The tree provides food and shelter for many animals of the forest, such as insects, small mammals, and birds. Each tree in the forest can be considered an individual ecosystem.

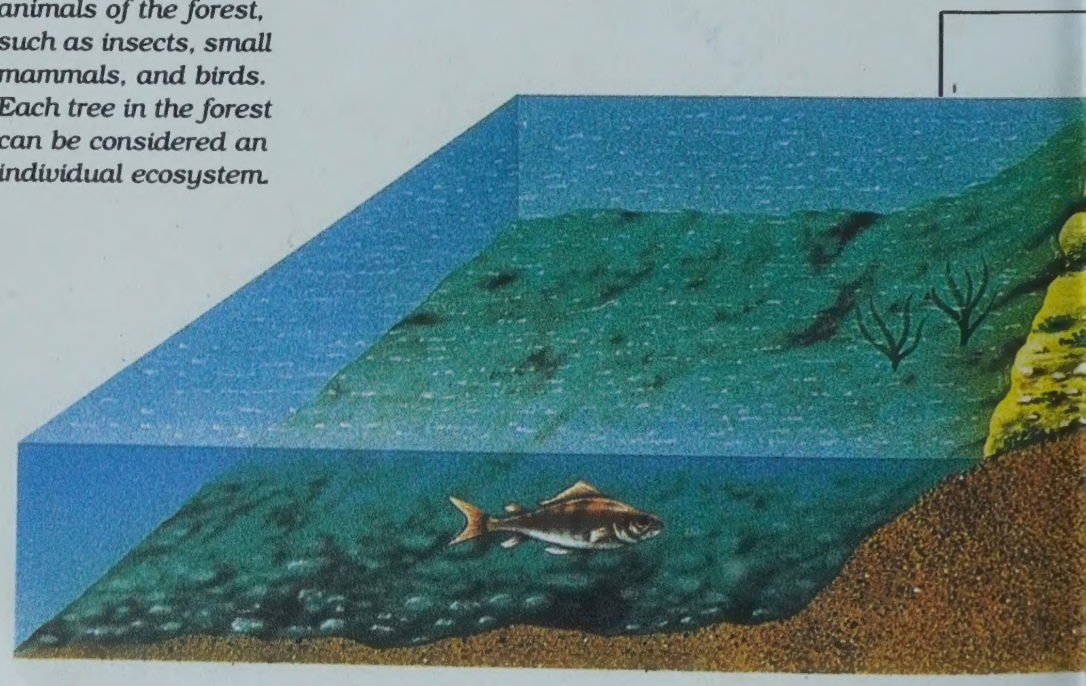
Biotope and Ecosystem

There is a great diversity of life forms that inhabit our world. They include, among others, trees and bushes, insects, mammals, and birds. They all go through the same processes of birth, development, reproduction, and death.

The development of a living being not only depends on the processes that take place within its body, but also on the characteristics of the place where the creature lives.

A region with uniform ecological conditions—including climate and temperature, precipitation, soils and surface vegetation, and food sources—is what is called a biotope.

Taken together, the community of living organisms occupying a biotope is known as a biocenosis. The biotope and the biocenosis are known collectively as an ecosystem. A lake, a field, a brook, a forest, or even a single tree trunk are all examples of ecosystems.



The Relationship Between Ecosystems

Although an ecosystem is self-sufficient, it is normally connected to other ecosystems.

For example, fertilizer used by a farmer in one of his fields can be carried away by the rain and contaminate the water in a nearby brook. After spending part of their lives on the surface of the water, certain insects, as adults, fly off to the forest or to the fields in search of food. Certain types of birds that have their nests in the forest also look for their food in the fields.

The Forest Ecosystem

The living beings that inhabit the forest are adapted to take advantage of this ecosystem's specific conditions. For example, the shape and size of leaves and the depth of roots in the ground assures trees an abundant supply of water throughout the year. The thickness of an animal's fur or hair and a bird's feathers conserve body heat during the cold winter months.

The forest is a good example of how organisms have adapted to living in specific ecosystems.

When animals and plants live together in a specific physical environment, they create an ecosystem. A certain type of forest will be formed according to the type of animals and plant life present.

▼

Birds can gather food from different ecosystems.
Life in the forest is also related to neighboring ecosystems. The connection takes place by way of air currents, water, and roving animals.
Many animals feed off different types of food, thus assuring their survival in unfavorable conditions.

Disturbances in the Ecosystem

What Is a Disturbance?

Disturbances are actions that alter the workings of an ecosystem. They may come in the form of a forest fire, the fall of a tree, a very dry summer, a plague, or a storm. They either originate from nature itself, or they are a consequence of the interference of human beings.

The Forest's Defense Mechanisms

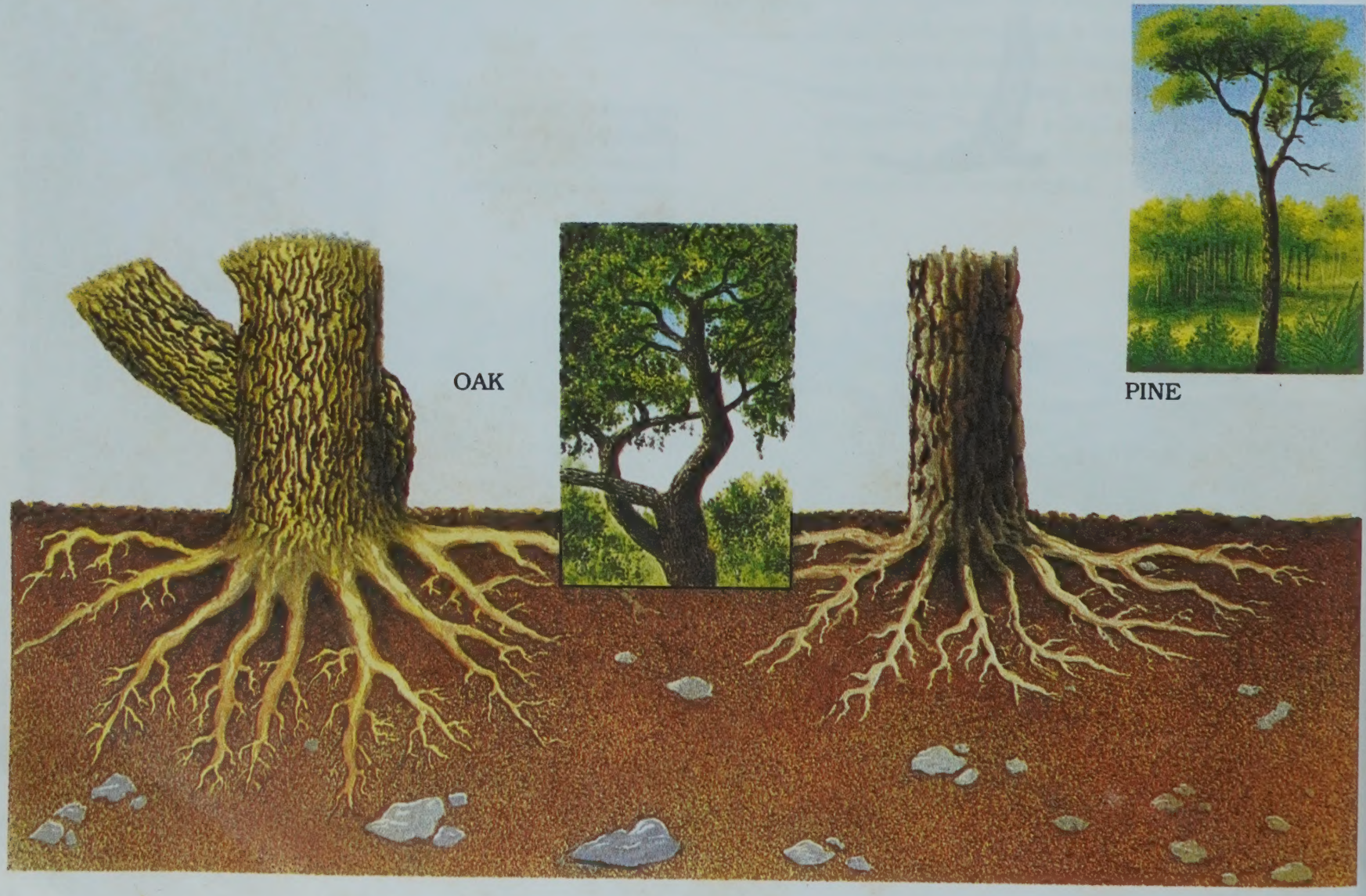
The forest can resist certain types of disturbances. For example, the bark of an oak protects the tree from the high temperatures of a fire; the pine's deep roots allow it to survive during periods of drought. Other survival tactics can be seen in the way some plants produce new shoots or germinate new seeds after a fire.

Effects on the Forest

The consequences of a forest fire, a plague, or a tree felling depend on the exact type of damage done to the ecosystem's elements, and on which animals and plants are destroyed or threatened.

If the plants have been almost totally destroyed, two things can occur: new plants may grow from the few undamaged shoots, or seeds that have fallen onto the ground from plants in other ecosystems may germinate and grow there.

Two trees that have adapted well to changes in the environment. The bark of the oak makes it more resistant to fire. The pine gives up very little of the water in its leaves through transpiration, allowing it to survive in dry climates. Deep-penetrating roots also enable trees to receive more water from the ground. ▼

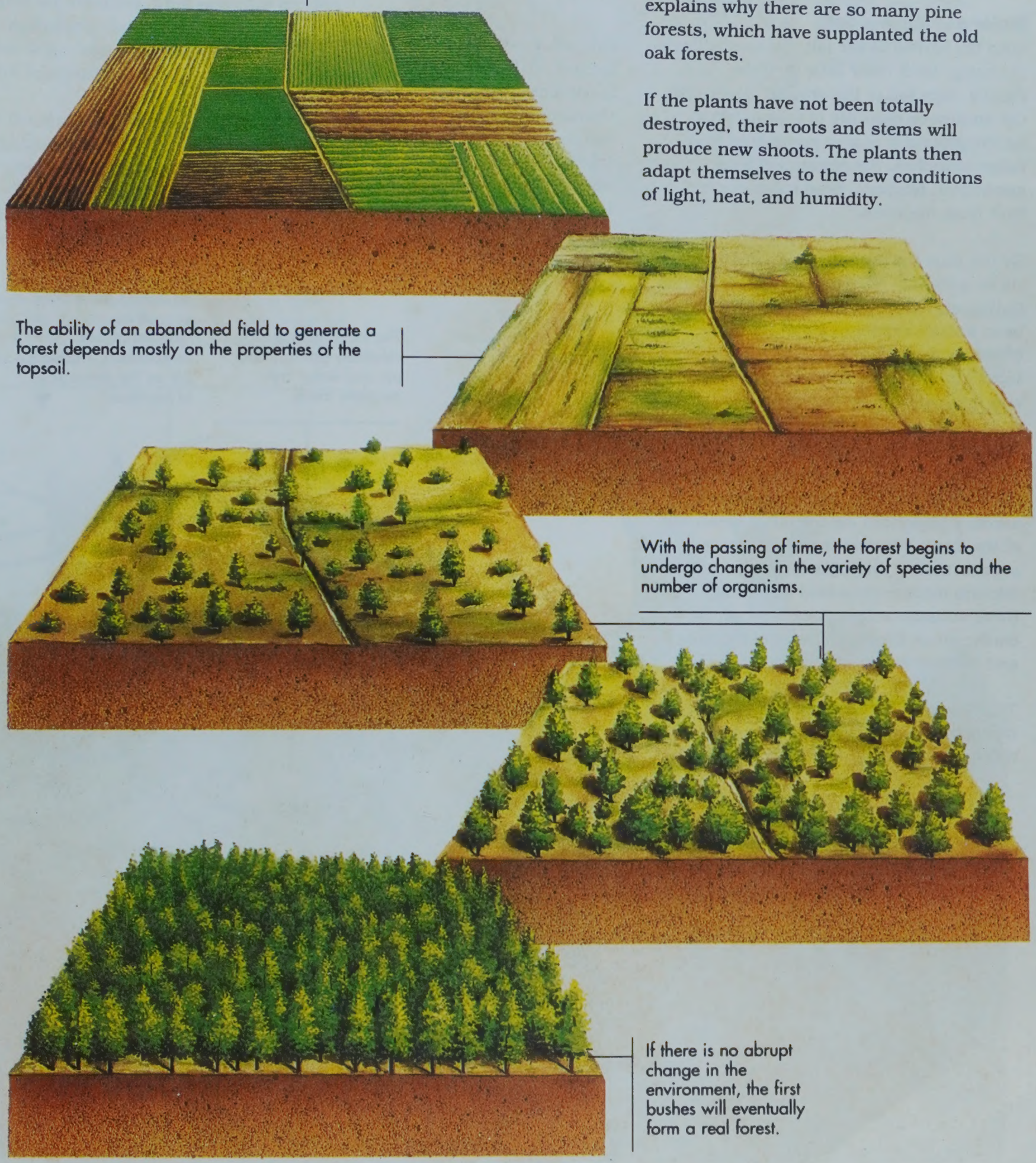


The growth or regrowth of a forest is a slow process in which the life that has developed on the forest floor forms a community of new organisms. Some forests have originated from agricultural fields that have been abandoned.

A New Forest is Born

In the latter case, a different type of forest will grow and flourish with time. This explains why there are so many pine forests, which have supplanted the old oak forests.

If the plants have not been totally destroyed, their roots and stems will produce new shoots. The plants then adapt themselves to the new conditions of light, heat, and humidity.



The ability of an abandoned field to generate a forest depends mostly on the properties of the topsoil.

With the passing of time, the forest begins to undergo changes in the variety of species and the number of organisms.

If there is no abrupt change in the environment, the first bushes will eventually form a real forest.

The Forest Floor

Water and Mineral Salts

With the arrival of the fall, the leaves begin to change their color little by little. Finally, they fall to the ground. Along with the enormous quantity of fallen leaves on the ground it is also possible to find fallen branches, the remains of food, excrement, feathers, dead animals, and fruit from the trees.

By the time the summer has returned, all these materials on the forest floor—thanks to the rain, heat, bacteria, and fungi—have been transformed into a spongy, dark-brown carpet of humus. The humus and topsoil of the forest floor are where water and minerals can be found.

A World Teeming with Life

The forest floor is inhabited by microscopic life such as bacteria and fungi, which are very important for the other creatures of the forest because they decompose organic matter and transform it into mineral matter. Dissolved in water, these substances circulate through the earth, where they are absorbed by roots and become incorporated into the plants.

The importance of the forest floor lies in its capacity for retaining air and water. When it rains, water is retained and filtered by the soil, leaving nutrients and minerals behind. The roots that die periodically decompose, creating underground channels where air is found. This allows the organisms that dig and live underground, such as worms and ants, to construct a network of tunnels underground without suffocating.

The organisms that live underground play a major role in protecting the humus as well as maintaining its composition, enabling life on the forest floor to continue. ▼

Organic matter is present on the forest floor because of the animals and plants that live on it.
The forest floor is relatively porous, and air and water can circulate freely.

A Network Against Erosion

The tree roots form a network in the forest floor in which minerals and organic matter are retained. This prevents erosion and maintains the humus layer of the forest floor, which is essential for life in the forest ecosystem.

The humus and the great variety of organisms within it, the minerals found in the soil, as well as the air and water circulating through it, form the foundation on which life in the forest develops.

◀ *A profile of the forest floor reveals its vertical composition and the layers of soil of different colors and consistency.*

Animals such as moles, mice, and shrews have special toes for digging tunnels and nests under the earth. Others, such as the fox, also make their home in the ground.

Roots are an essential part of the tree because they absorb water and minerals from the ground. Some species have very deep roots to enable them to search for water in the deeper layers of the earth.

The Destruction of the Forest

Rain and Wind

Life on the forest floor developed over a period of centuries. If the forest floor were destroyed, it would take many years for the ecosystem to recover.

Rain and wind are the two most important factors in displacing the material that makes up the forest floor; both contribute to what we call surface erosion.

Erosion affects all the world's forests. Every year, torrential rains and strong winds in dry regions carry tons of fertile earth out to sea, where they are lost forever.

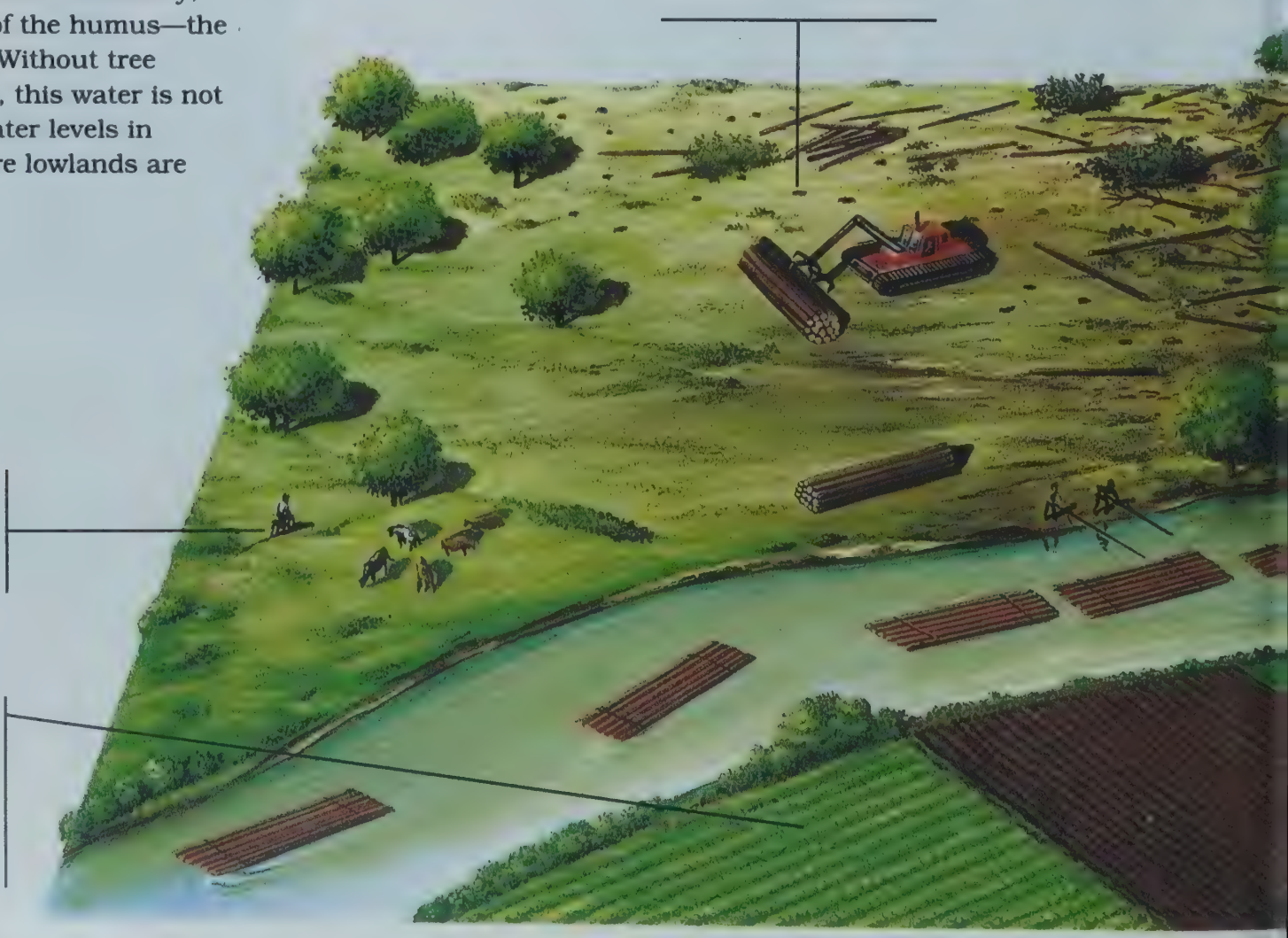
After intense rainfall on steeply sloped ground, water runs down to the valley, carrying with it much of the humus—the forest floor's top layer. Without tree cover and root systems, this water is not absorbed and raises water levels in rivers to the point where lowlands are flooded.

The Hand of Man

However, most of the damage inflicted on the forest floor is caused by human beings. New towns, industrialized areas, reservoirs, dams, and roads are being built in forested areas. In other cases, land has been cleared for farming.

Human beings have also been the cause of frequent forest fires, which also contribute to the destruction of the forest floor.

The forest floor takes a long time to form. The process is very complicated and requires nature to carry out a lot of work. This is often interrupted by human activity, which can destroy the forest floor. ▼



Tree felling and the subsequent abandonment of the land leaves the top soil unprotected.

Recreational activities involving off-road vehicles can also destroy the ground.

The use of forest land for farming can alter the composition of the ground because of the use of fertilizers and irrigation water.

Erosion Destroys the Forest

The result of all this is that a great number of trees are disappearing. Trees are the main support of the forest floor because they provide it with organic matter. Moreover, without vegetation, the floor suffers more erosion by rain and wind, which displace the nutrients needed by plants and trees to grow. The continuing disappearance of vegetation results in animals having to find other areas that can provide them with food and shelter. The young herbivores, incapable of feeding themselves, die of hunger.

The progressive disappearance of vegetation in a forest is called deforestation. Deforestation in turn affects the forest floor and life on it.

If the top soil is destroyed or carried away, many centuries are required for it to regenerate from the rock or mineral stratum below. This is why, in order to protect treeless top soil, people have constructed terraces so that the material that would be carried away can be held in place.

Light in the Forest

Light and Water

Light and water are two indispensable elements for the survival of plants. Plants take in sunlight through their leaves and absorb water and minerals from the ground through their roots. These three elements make up their food.

Trees have an advantage over the other plants in the forest: they can receive and make use of sunlight by way of their crown, which is in a high, prominent position. Similarly, their roots, which are generally wider and deeper than those of other plants, allow them to take in more water and minerals.

However, trees also have certain disadvantages: high trees are more vulnerable to lightning, to strong winds, and to snow storms.

Layers of the Forest

Depending on their height, the plants in a forest are grouped into several layers: the arboreal or canopy layer, the understory, and the forest floor.

The canopy determines the quantity of light and warmth available to the ecosystem. The understory is formed by a layer of bushes, shrubs, and immature trees. The forest floor consists of ferns, herbs, fungi, and moss. The subterranean layer is comprised of root systems, fungi, insects, worms, and microscopic organisms.

Not all the layers of the forest develop at the same rate.

▶ *When the arboreal layer is very dense, as is the case in a beech forest, the environmental conditions in the forest change considerably. The amount of light and heat is much lower than that of an open area. The interior of a beech forest is dark and humid, and there is hardly any air circulation.*

▶ *When the arboreal layer is formed of pine trees whose tree tops do not cover the sky, a lot of sunlight penetrates the forest interior. The pine forest is dry and warm, especially in summer. The leaves of the pine trees are perennial and resist both the heat and the cold.*

THE LAYERS OF THE FOREST

ARBOREAL LAYER.
This is formed by the tree tops, which filter the light and heat that the other layers receive, determining how much vegetation and animal life can survive below the tree tops.

UNDERSTORY.
Formed by immature trees and the highest shrubs and bushes (blackberries, roses, and other wild plants).

HERBACEOUS LAYER.
This is formed by tender stemmed plants such as daisies, clovers, and ferns.

THE FOREST FLOOR.
This is formed by moisture-loving plants and fungi such as grass, mushrooms, and lichen.

SUBTERRANEAN LAYER.
This is held together by the roots of plants.

Living Creatures in Action

Producer Organisms

Green plants owe their color to chlorophyll. They are the only beings capable of producing organic matter, that is, food.

Green plants take in carbon dioxide from the air and water from the ground. These two elements are transformed into starch and other organic molecules rich in energy, thanks to the sunlight they receive.

The starch is produced in the leaves and reaches all parts of the plants through vessels in the stem and branches. The process of food production from sunlight is known as photosynthesis. Plants that are able to produce food in this way are called autotrophic or producer organisms.

The necessary raw materials for food production are the carbon, oxygen, and hydrogen molecules found in the environment. Plants obtain these substances from carbon dioxide, which penetrates the leaf through the stomas, and from water, which enters the plant by way of its roots.

Consumer Organisms

Since animals do not have chlorophyll, they cannot synthesize their own food and therefore they have to take it from plants. Animals are heterotrophic or consumer organisms.

Vegetable-eating consumer organisms are called herbivores. The mainly animal-eating creatures are called carnivores. Certain organisms that consume both plants and animals are called omnivores.

The Carbon Cycle

Only plants are capable of taking in carbon dioxide and giving off oxygen. Just like other living creatures, plants also respire, that is, they take in oxygen and breathe out carbon dioxide, but they take in much more carbon dioxide than oxygen. Green plants are essential to the carbon cycle, removing carbon from the air, storing it in living tissue, and transferring the carbon to other organisms when the plants are eaten.

The Nitrogen Cycle

Nitrogen, like carbon, is an essential element in plant life. It is found in abundance in the atmosphere, but plants cannot make use of it in a gaseous state.

Nitrogen is transformed on the forest floor into substances called nitrates. This transformation is carried out by bacteria in the soil. Nitrates are absorbed by plant roots to form part of the plant's tissues.

From plants, nitrates pass from one link to another in the food chain, and end up returning to the forest floor through the decomposition of dead bodies and excrement. This is called the nitrogen cycle.

Just like water, nitrogen and carbon circulate through the food networks of an ecosystem. These basic life-giving substances are found in the atmosphere, the ground, and the water, and are used to promote the continuation of life in the ecosystem. ▼

The Greenhouse Effect

A Natural Regulating System

There is a basic relationship between the photosynthesis of green plants and the respiration of living beings. This relationship not only maintains forest life but it also preserves the biosphere.

When living beings breathe, they exhale carbon dioxide into the air. The only organisms that can exhale oxygen into the air are plants. Both functions are considered to be complementary: that is, carbon dioxide is considered essential for photosynthesis, whereas oxygen is indispensable for animal and plant respiration.

Carbon dioxide is one of the principle gases responsible for the greenhouse effect. These gasses retain the heat the earth needs to support life and prevent the planet's excessive cooling.

Trees and plants absorb great quantities of carbon dioxide, thus acting as controllers of these gases.

Global Warming

But the levels of carbon dioxide in the atmosphere can change dramatically. The cause is normally attributed to the deforestation of large areas of land all

The earth's surface gives off heat, part of which is retained by the gases in the atmosphere before it radiates into space. The phenomenon is known as the greenhouse effect. But any build-up of these greenhouse gases will prevent the atmosphere's regulating function from working. ▼

The incineration of solid wastes produces different gases which, when emitted into the atmosphere, intensify the greenhouse effect.

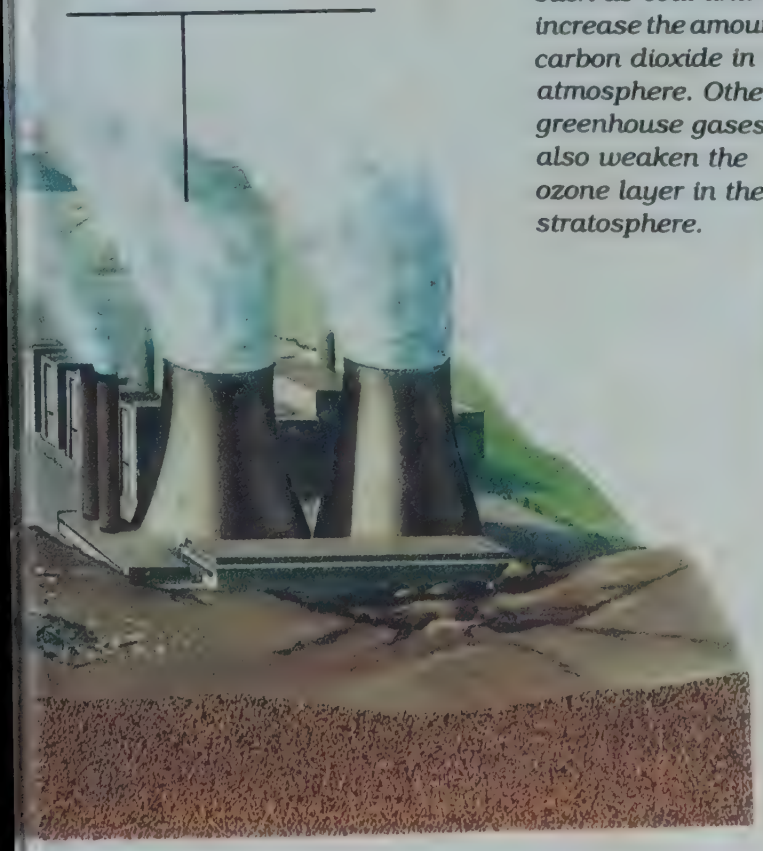
The burning of trees gives off carbon dioxide, which is one of the greenhouse gases.

over the world. The disappearance of entire forests can increase the amount of carbon dioxide in the atmosphere. This gas will trap large amounts of heat in the lower reaches of the atmosphere.

Furthermore, industrial activity as well as automobiles and electrical devices need combustible energy sources such as coal, oil, and natural gas. When these fuels burn, they give off large quantities of carbon dioxide.

The emission of such gases along with deforestation can increase the greenhouse effect and raise the temperature on the earth's surface.

Today, industries and power plants are great producers of many of these gases.



The disappearing forests and the increasing use of combustible fuels such as coal and oil increase the amount of carbon dioxide in the atmosphere. Other greenhouse gases also weaken the ozone layer in the stratosphere. ▶

Food Chains

The Links in the Chain

The search for food creates connections between the animals and plants of the forest. The food relationship among the different organisms of a particular ecosystem is known as a food chain.

Every food chain has at least four levels or links. The first link is the green plants, which are known as producer organisms because they manufacture their own food.

The second link consists of herbivorous animals, which feed on the primary consumers. They are the secondary consumers. The third link is made up of larger carnivorous animals who eat the herbivores and are called the tertiary consumers.

The fourth link is made up of microorganisms: bacteria and fungi. Together, they feed on the remains of dead creatures. For this reason they are called decomposers.

The Food Network

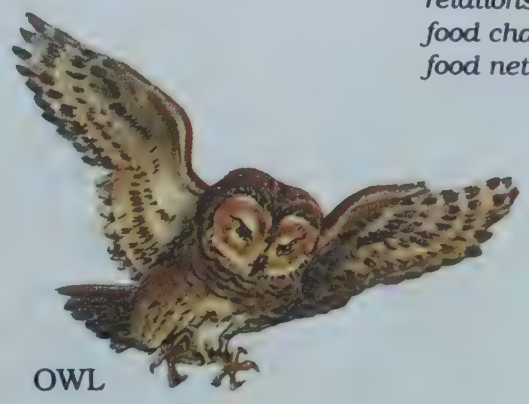
It is important for carnivorous animals to be able to change their diet by finding food at different parts of the food chain, or even in different food chains. For example, snakes are rarely eaten by foxes. Foxes often eat shrews, mice, and beetles, and in turn beetles eat fly larvae. Hedgehogs mainly eat spiders and insects, but they can also eat snakes.

The animals of the forest establish different relationships that transcend established food chains, and these broader relationships create complex food networks.

A simple food chain consists of at least four links: green plants—which produce their own food from solar energy—the herbivores, carnivorous animals, and the decomposers. Decomposers are bacteria and fungi that usually live on the forest floor and feed on animal and plant remains. ▼

The animals of a forest food chain can eat animals from other chains. The relationship between food chains forms a food network.

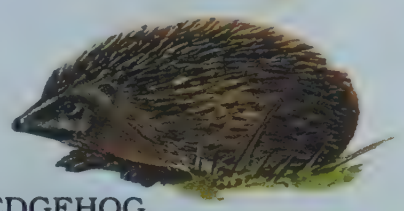
FOX



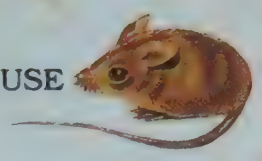
OWL

RABBIT

WEASEL



HEDGEHOG



MOUSE

FROG

SNAIL

Energy Loss

Energy Pyramids

A link in a food chain is also called a trophic level. When we compare the amount of energy at each trophic level we see that the farther we get from the primary producers—that is, plants—the lesser amount of useful energy there is.

Man and Food

All the living creatures in the forest obtain the energy they need to grow through food. This is also true of human beings. However, the ecological behavior of human beings is slightly different from that of other creatures. Human beings require a great deal of energy, and obtain much of it from non-food sources.

Resource Use

In ancient times, human beings exploited an area until they had exhausted all its resources. Then they would move on to another area and repeat the same process. Later on, more developed civilizations abandoned this nomadic exploitation of resources and started transporting food and other resources from their original area to the place where they were to be consumed.

Nowadays, the main consumer centers are the big cities, which makeş it necessary to transport resources there. A great deal of energy is required for the transportation and transformation of food and other resources.

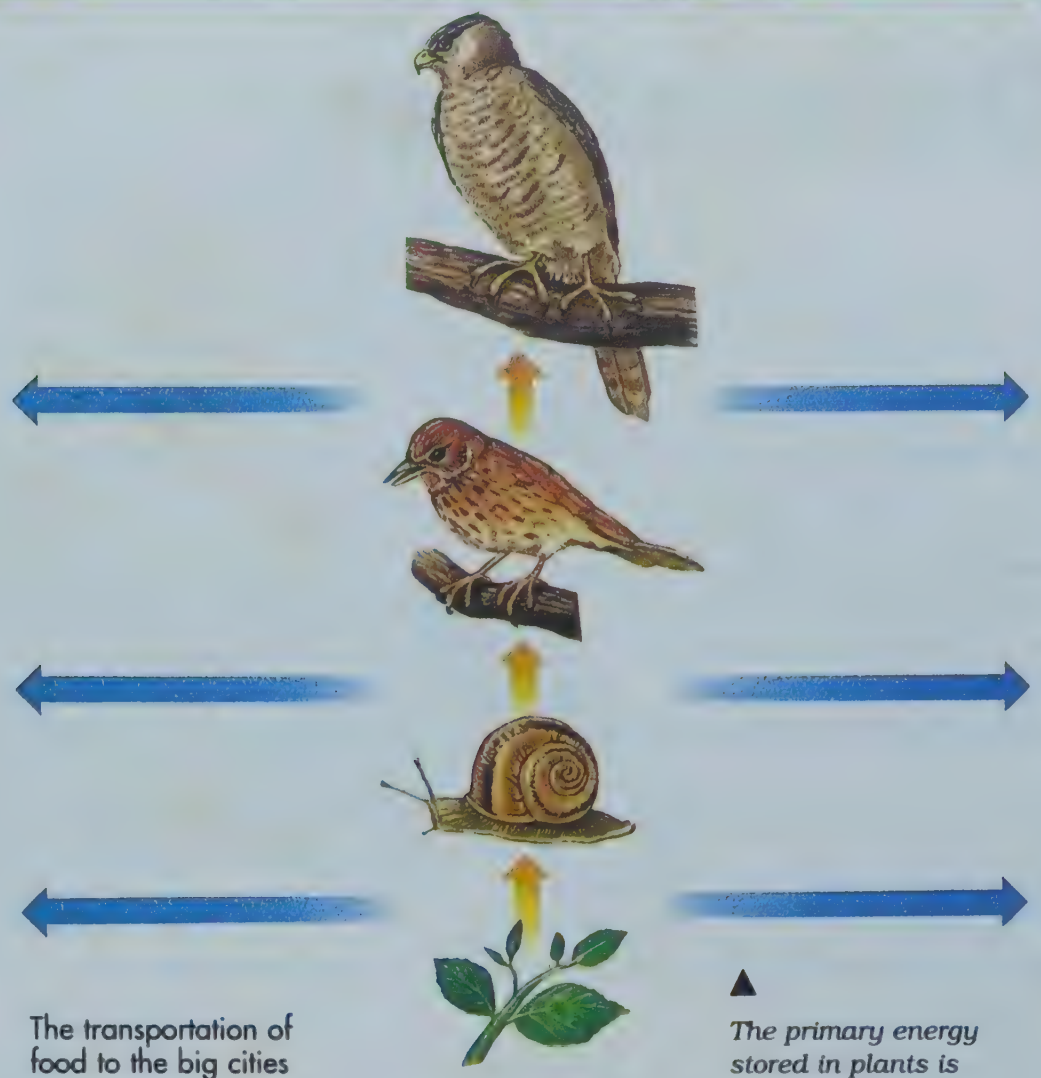
The transformation of the landscape by the first humans was relatively insignificant. Later on, farming and cattle raising increased. Over the last few years, farming, cattle raising, and the construction of big cities and industries have produced an enormous transformation of the natural landscape.

▼

Nowadays, man exploits the forest excessively.
The need for food has resulted in the conversion of forest areas into fields where crops can grow.
Ranches have substituted pastureland for forests.

Accumulation of Waste

Energy production and the transformation of materials entails waste production. Because of the great quantity of energy required in some societies, waste accumulates in the air, water, and on the ground. Such accumulation produces pollution.



▲ *The primary energy stored in plants is consumed and passed from one organism to another, providing a source of energy to creatures who cannot produce it themselves.*

The transportation of food to the big cities requires new roads, railways, and highways that result in the destruction of more forest.

Some industries not only pollute, but even promote the disappearance of natural landscape when ecological criteria are not taken into account.

Deforestation

Deforestation refers to a number of processes through which a forest loses its vegetation, that is, its trees and plants. Nowadays, forests suffer from intense deforestation. Great tracts of forest are being felled to obtain wood. The construction of hydroelectric power stations and the building of new roads and railways also cause deforestation.

Unfortunately, when deciding on the place for a new factory or the construction of a new road or railway, economic criteria generally predominate, and the effects on the landscape are hardly taken into account.

Some of these actions can transform the natural environment and destroy the forest.

Causes of Deforestation

Forest vegetation can resist natural phenomena such as storms and strong winds, and even some human actions. Forests can recover from such phenomena and will return to their natural state.

But this restorative ability has its limits. Some alterations can bring about the permanent disappearance of the forest. Continued erosion of the soils, inadequate replanting programs and improper forest management, and fires are just some of the phenomena that can result in the destruction of a forest.

The planting of trees after a forest fire is normally carried out using a mixture of species. Some will be native to the area while others are chosen for their rapid growth and valuable wood.

▼

BURNED FOREST

REFORESTATION

Pollution

By exploiting different resources, humans have transformed or destroyed the forests. But, apart from this action, the survival of the forest is endangered by another factor: pollution. Pollution reaches the forest through the air, water, and land. An example of this is acid rain, which will be explained on the next page. All these actions constitute attacks on the forest that can lead to desertification. Some of the great deserts of the earth were once great forests.

Forests have always been a source of raw materials essential for human beings. The forest produces wood, fiber, cork, firewood, fruits, and game. Nowadays deforestation is a real danger because of excessive tree felling, fires, and different forms of pollution.

In ancient times, forest fires were considered to be good, as they opened up areas for cattle grazing and farming and renewed forest species. Nowadays, fires are one of the main threats to the forest.

Forest fires are the main factor in desertification, as plants do not have enough time to sprout again and therefore disappear little by little.

Acid Rain

Acid Substances

Some substances, such as lemon juice or vinegar, have a characteristic acidic taste. The pH scale is an indicator used to determine the degree of acidity of a substance. On the pH scale distilled water is neutral with a reading of 5.

When rain water has a degree of acidity lower than 5, it is acid; this means that is contains some dissolved acid substance, generally sulphuric and nitric acid. Such acids form in the atmosphere from gases produced by power stations, industries, and motor vehicles.

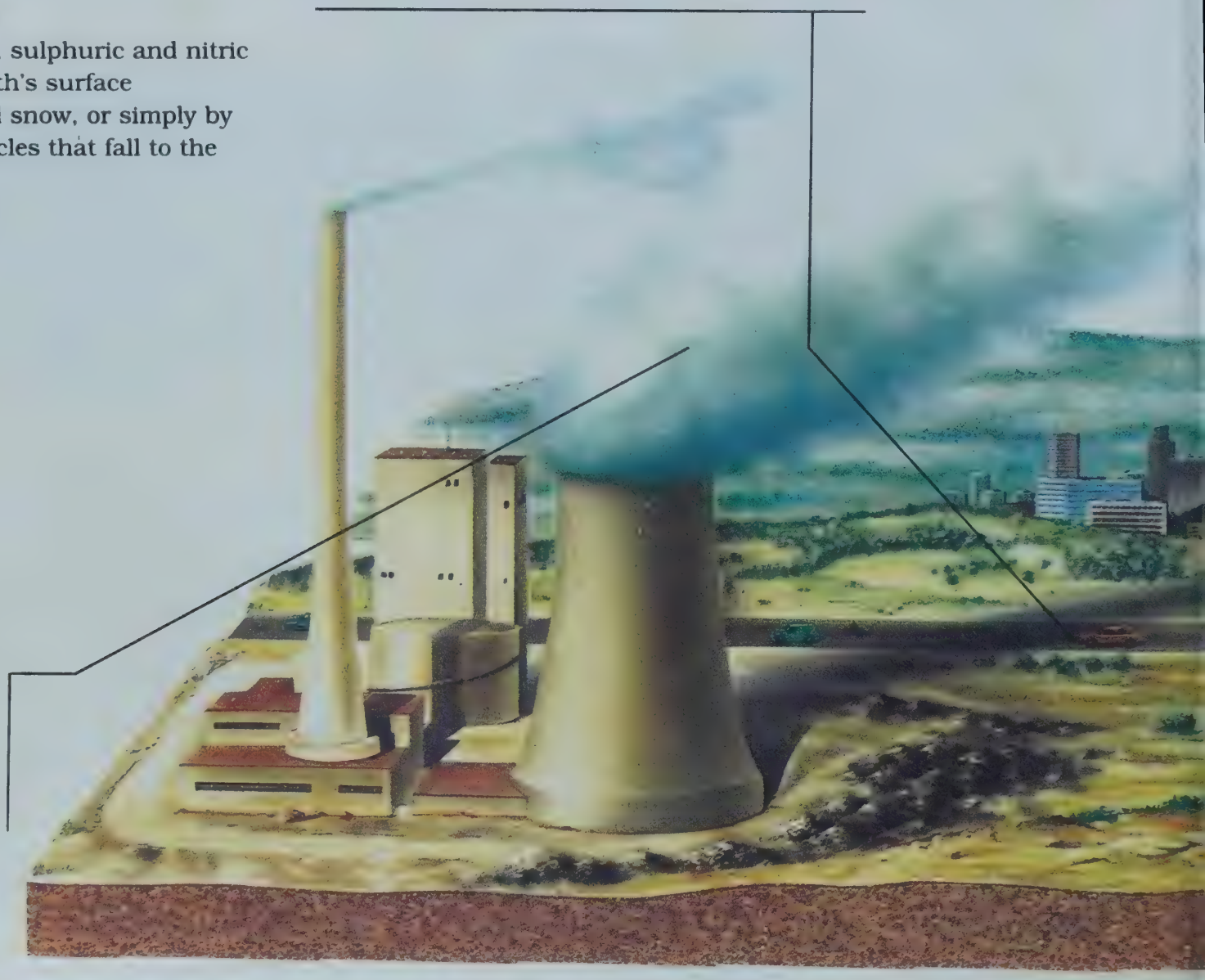
Contaminating Acids

Once they are formed, sulphuric and nitric acid return to the earth's surface through rain, fog, and snow, or simply by bonding to solid particles that fall to the ground.

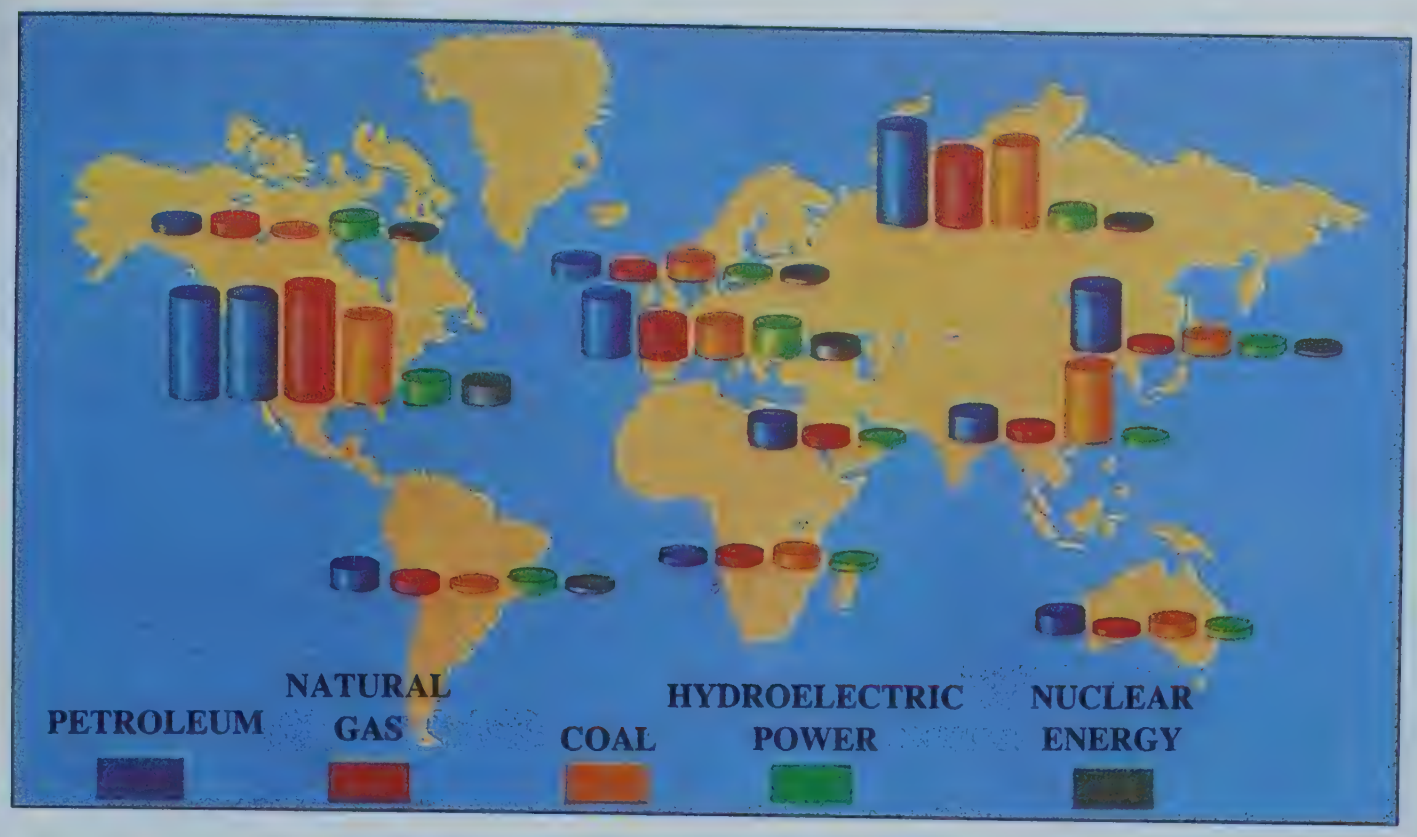
Acid rain transmits its acidity to rivers, oceans, and lakes, to villages and cities, to fields and forests. Such acidity impoverishes the nutritional capacity of the soil as it alters the population of microorganisms. Forests are subjected to the effects of acidity as well, because the rain and low clouds contain acid particles.

One of the main reasons why forests disappear is acid rain. Contaminants reach the forest with the rain and snow. They land on the leaves and on the forest floor. ▼

Motor vehicles produce gases that turn into acid. This is the reason why highly populated areas are also great producers of acid rain.



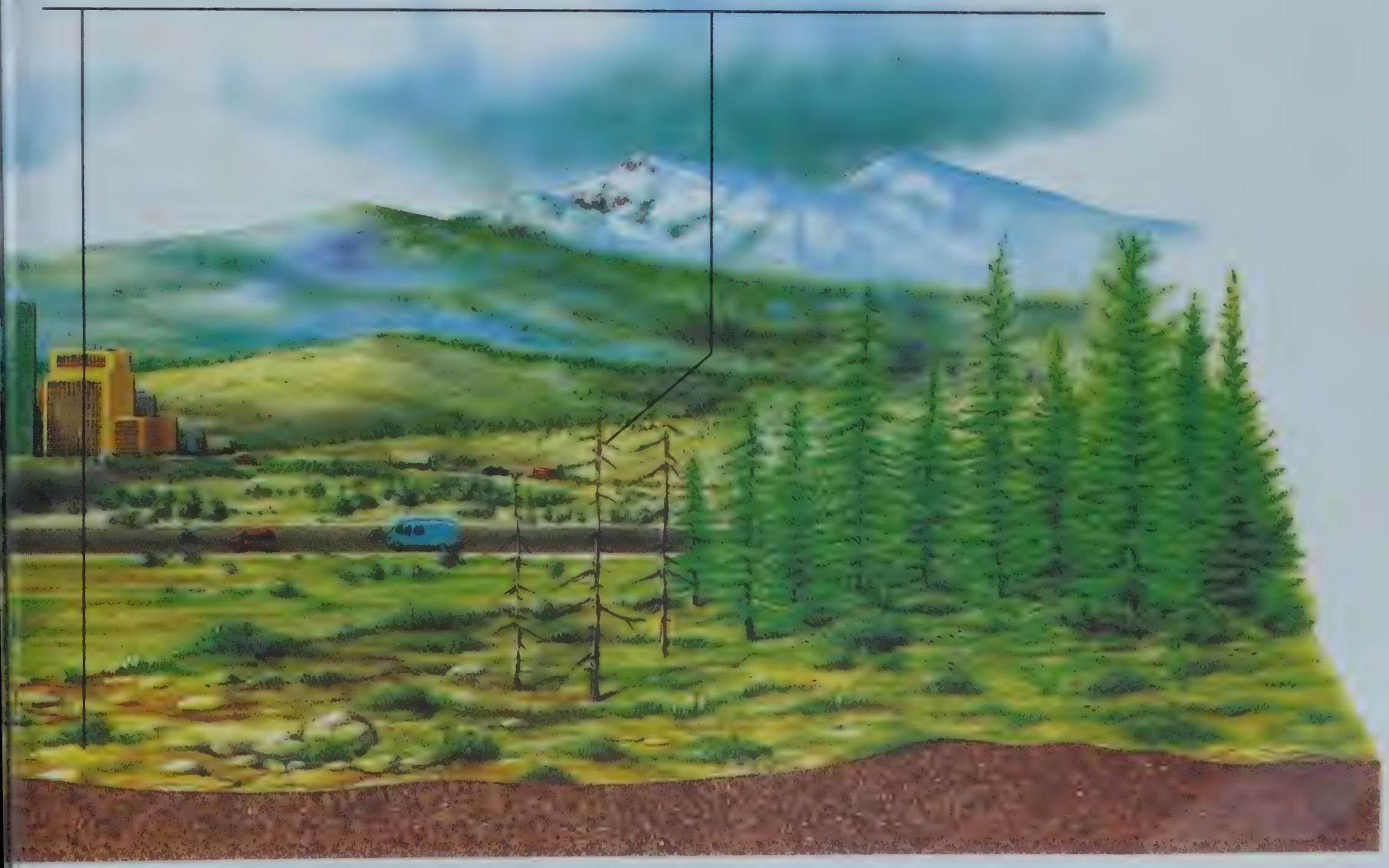
Sulfur and nitrogen oxides are transformed into acids when they come into contact with atmospheric gases.



The term "acid rain" began to be used in the last century, when the connection between the generation of air pollution in big cities and the death of forests was first noted. The production of energy—the illustration shows world energy consumption—can create toxic gases if measures are not taken to control industrial emissions in every country.

Acids alter soil composition, which impedes the production of nutrients necessary to life in the forest.

One of the first effects of acid rain on trees is the loss of their leaves.



Climate, Landscape, and Forest

Climatic Zones

Depending on latitude (the distance between different areas and the equator) three main climatic regions can be distinguished. In the equatorial region, on both sides of the equator between the tropics of Cancer and Capricorn, tropical forest or jungle is found. The temperate region, between the tropics and the polar circles, contain deciduous forests. The polar regions, between the polar circles and the poles, are generally made up of tundra.

But the earth's surface is not uniform. There are mountain ranges that are very high. Depending on their height, areas in the same region will have different climates: either mountain, low-mountain, or plain climates. The combination of latitude and altitude determine the different landscapes of the earth.

However, wherever a forest is, many other factors—soils, local weather, a particular mix of species—will give it a unique ecology, though the basic processes of nature, the cycling of nutrients and important elements, goes on in all forests.

The different types of forests are found in various climate zones. The zones are determined by latitude, and each zone has a characteristic type of forest—swampy forest, northern boreal forest, or tropical forest. The distribution of these forests is not as uniform as the illustration suggests. Other factors, such as altitude and local climatic factors, also determine where a specific type of forest will be found.

Vegetation is common in the mountains and varies according to climate and height. The higher the mountains, the lower the temperature and the more rainfall there is. Vegetation also varies depending on the north or south orientation of the slope.

1. *The tundra, formed by lichen and moss, covers the most northerly land masses. Just to the south is the taiga, or northern forest.*

2. *Coniferous trees adapt themselves to cold climates. Their conical shape helps them to combat wind and snow.*

3. *Deciduous trees, such as oaks and beeches, are characteristic of temperate climates.*

4. *Tropical rainforests are characteristic of the warm climates of the earth.*

1

2

3

4

Activities

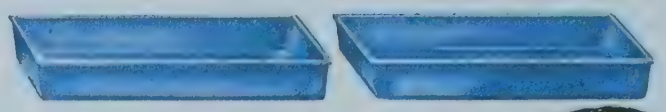
The Effects of Erosion

You can conduct an experiment to demonstrate how vegetation reduces the rate of soil erosion. Follow the instructions below.

MATERIALS

two beakers of water

two wooden boxes



two plastic trays

leaves, herbs, roots, and stems

earth

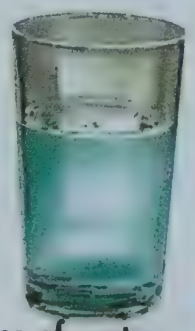
1. Pour water through a wooden box of plain earth.

2. Pour water through a wooden box containing earth and plant material.

3. Observe that when plants are rooted in the earth, water runs through it more slowly and fewer soil particles are found in the plastic tray.

The Absorption of Nutrients

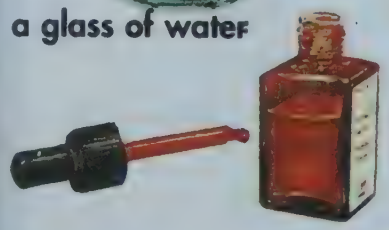
In this experiment you will see how plants take up nutrients through special channels in their tissues.



a glass of water

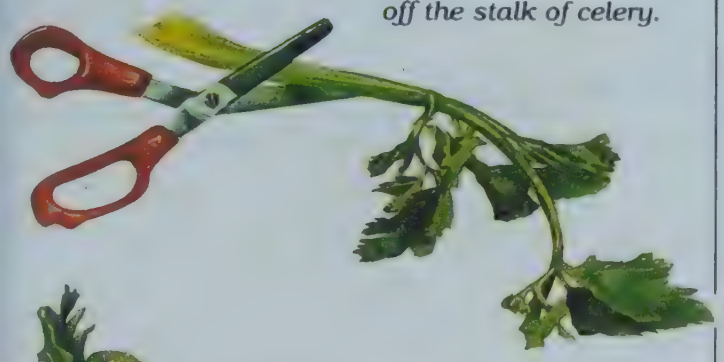
MATERIALS

1. Place several drops of red dye or mercurochrome in the glass of water.



red food coloring or mercurochrome

a stalk of celery



2. Cut the bottom end off the stalk of celery.

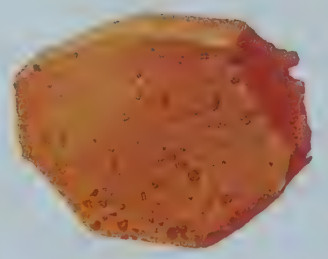
3. Place the cut end of the celery stalk into the water.

4. After several hours, observe how the colored water has been drawn up through veins in the celery.

Observing Insects

Here is a way to build a simple home for insects and observe their activities.

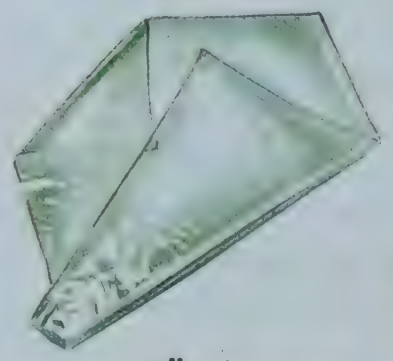
a sponge

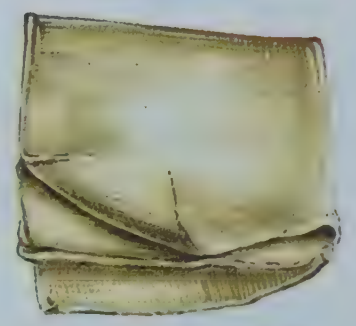


MATERIALS

a plastic bottle

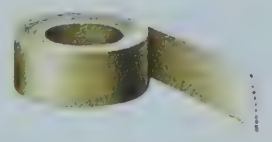
a sheet of cellophane



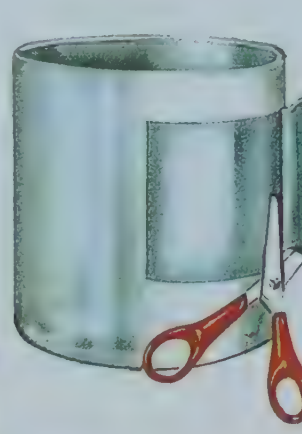


a piece of cheesecloth

adhesive tape



a rubber band



1. Cut off the top of the plastic bottle and cut an opening in one side.

2. Cover the opening with the clear cellophane, securing it with adhesive tape. Dampen the sponge and place it inside.

3. Stick a plant stem into the wet sponge. Place the insect inside the bottle and cover the top opening with the cheesecloth and the rubber band.

Words to Remember

Biotope A region characterized by uniform ecological conditions, including soil, humidity, climate, and biological organisms.

Chlorophyll A green pigment found in plants that can capture sunlight and use its energy to create new organic compounds through photosynthesis.

Carbon dioxide A gas present in the air that plants absorb to carry out photosynthesis; all living beings breathe out carbon dioxide during respiration.

Decomposer A microscopic organism that feeds on vegetation and animal remains.

Erosion The wearing away of the earth caused by water, wind, and human activity.

Food chain A relationship between a group of plants and animals who depend upon each other for food.

Humus Substances resulting from the decomposition of dead creatures on the ground by way of bacteria and fungi.

Photosynthesis Synthesis of organic molecules by plants using the energy of sunlight.

Pollution Accumulation of pollutants in the air, water, or on the ground, which produces changes in the functioning of the ecosystem.

Predator A carnivorous animal that hunts other animals for food.

Producer Living beings that make their own food out of carbon dioxide and water by using sunlight.

Trophic level The role that an organism plays in a food chain (producers, consumers, etc.).

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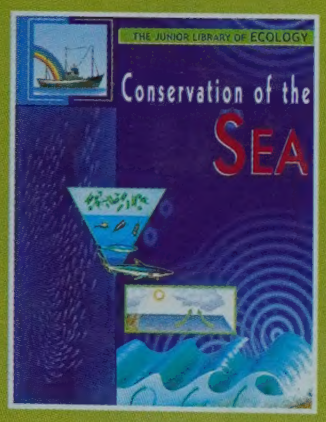

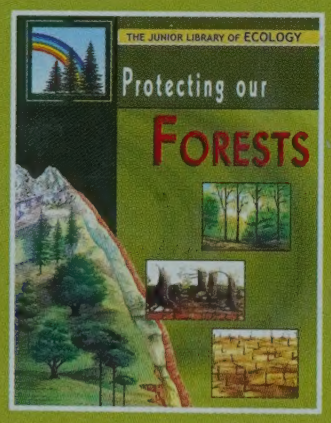

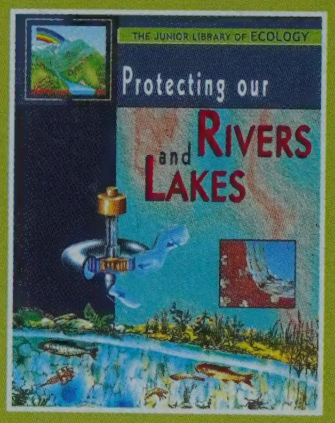

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